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BELLCOMM, INC.

(NASA CR OR TMX OR AD NUMBER)

(CAT-5000)

SUBJECT: Discussion with MSC on Environmental Control System Tubing Joints,
April 27, 1967 - Case 330

DATE: May 2, 1967

FROM: S. S. Fineblum

MEMORANDUM FOR FILE

Preliminary findings of a study on tubing joints were discussed at MSC on April 27, 1967. Charts used for this discussion are attached. The objective of the study was to survey the state-of-the-art in light of the current tubing joint problems in the CSM. R. Gillen, E. L. Hayes and F. Samonski of Crew Systems Division, and F. E. Benson of the Structures and Mechanics Division were present.

Determination of any changes in ECS tubing joints require three separate efforts:

1. Understanding the problems,
 2. Evaluating the present state-of-the-art for potentially useful techniques, and
 3. Selection of the technique most consistent with the program constraints.

It is our opinion that the greatest knowledge of the present problem and the program constraints existed at MSC and NAA-SID. Therefore, the main responsibility for the first and third phases should be with MSC and NAA-SID. The state-of-the-art study has remained the author's main interest.

According to the related UR* and a ASPO letter** written by GE, APOLLO Support Department, the causes of solder joint failure are poor adhesion, installation and re-torque stresses, and the low creep stress.

***UNSATISFACTORY REPORT-S/C, Environmental Control System**
U.R. No A-062.

**NASA, MSC letter to J. C. Cozad from ASPO Conference to PR2-67), subject: "Contract NAS 9-150, Recommendations for Improvement in the Reliability of ECS Soldered Tubing Joints".



Present joints can be improved by:

- a. Protection of joints.
- b. General use of Voishan washers.
- c. Reduction of residual stress.
- d. Use of "Super" B nuts.

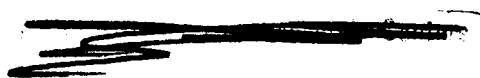
More advanced mechanical couplings have been produced which are demonstrably superior to the B-nut couplings. It is recommended that these fittings be actively investigated. In addition, the possibility of in-place brazing of aluminum tubes should be studied.



S. S. Fineblum

2031-SSF-sjh

Attachments
Briefing charts



April 21, 1967
S. S. Johnson

ECS TUBE CONNECTOR STUDY
(PRELIMINARY OUTLINE)

JOINT WORK.

- UNDERSTAND PROBLEM
- EVALUATE STATE-OF-THE-ART CHOICES
- UNDERSTAND PRODUCTION SEQUENCE AND STATUS

PROBLEMS

With FGS Joints and Connectors

1. LEAKAGE DURING NORMAL TESTS
2. LEAKAGE CAUSED BY MELTED
SOLDER

LEAKAGE DURING TESTS

MAINLY - Soldered Joints

.. 'B' Nuts

SOME - Dip Brazed Joints

Aluminum Welded Joints

FAULTY SOLDERED JOINTS.

LEAKS

DISCOVERED

- After Completion of Joints
- After Installation of Assemblies
- Hours and Days after Installation
and/or Retorqueing

LEAKS CAUSED BY .

- Poor Adhesion
- High Installation Stressess
- Rough Handling
- Low Creep Strength

SOLDER FAILURE DURING FURNACE HEATING.

CAUSED BY -

Low Melting Temperature

@@374°F

SEARCH FOR ECS TUBE CONNECTORS
AND JOINTS

FUSED METAL

17

MECHANICAL

17

PREFACE

PROBLEM

G. E. RELIABILITY
NAA-SID AND MSC

SOLUTIONS

BOEING-5

BATTEL-E-3

NAA - L. D.

GAE C

PRESS

COMMERCIAL LITERATURE

CRIITERIA FOR SELECTION

- ABSOLUTE
 - ZERO LEAKAGE
 - FIRE INSENSITIVITY
 - PROVEN PERFORMANCE
- RELATIVE
 - WEIGHT
 - SPACE
 - STRESS ON SYSTEM
- SUPPRESSED
 - COST

AVAILABLE JOINTS AND CONNECTORS

MUSSED METAL.

- > Brazed
- > Welded

RECONNECTABLE

- > Flared
- > Swaged
- > Self-flairing
- > Brazed-to-Union

SOLDERING:

(60 Sn 40 Pb)

- Low Creep Strength
- Low Melting Temperature - 374°
- Poor Axial Efficiency
- Requires Careful Cleaning and Plating
- Preparation Cannot Be Performed in Place

SOLDERING ..

(85 Sn 15 Bi)

- Melting Temperature Slightly Higher 420°C
- Axial Efficiency ≈ 100%
- Good Creep Strength

PERFECT PROOF
MASS

FUSED METAL JOINTS

- " 1/10 MECHANICAL
 - FITTINGS WEIGHT
 - SMALLER
- BRAZED
- WELDED

DRAWING METHODS

INDIRECT DRAWING

STAINLESS

DIP BRAZING

ALUMINUM

- Strong
- Light
- Reliable
- Small

BRAZED JOINTS

REQUIREMENTS

- 1 .. Clearance .. $\leq .060"$ Axial
..... $\leq .001"$ Gap $\leq .006"$
- 2 .. Surface Cleanliness
- 3 .. Interior purge

BRAZED JOINTS

MAA-SID- (PARKER)

SHORTER THAN GEMINI (AEROQUIP)

LOWER TEMPERATURE

BRAZING (1730° F < 2100°F)
ALLOY

- 97% PASS X-RAY
- 99.95% PASS ZERO LEAKAGE

BRAZED JOINTS

- AEROCOUP - Induction
- MORE ADVANCED
- CONSISTENT QUALITY
 - GEMINI, ORBITER, A.O.O., C.O.O.
- Boeing }
Grumman } Studies

FUSION WELDING

Tungsten Inert Gas

FLUXLESS

MINIMUM WEIGHT

NOT TEMPERATURE LIMITED

ZERO LEAKAGE

STRONG

AUTOMATIC FOR STEEL

LARGE $\geq 1"$ DIAMETER HEAVY CONNECTIONS

MICROKILOMETER WAVELENGTH

THIN FILM -

LIGHTEST - Low Δp

QUICK DISCONNECT

HEAVIEST - Low Δp

QUICK-DRY DISCONNECT

HEAVIEST - Large Δp

TUBING TO UNION JOINTS

- FLARED
- SWAGED
- BRAZED

FLARED TUBE CONNECTIONS

AN/MS

• MC 146 (MS 33584)
with Yoi-Shan washers

- MACHINED FLARE
- PRECISION SLEEVES
 - High Torque Requirements

THREADED.

- 1 FLARED TUBE
 - SELF-FLARING
 - METAL SEALS
 - " Integral
 - " Separate
-

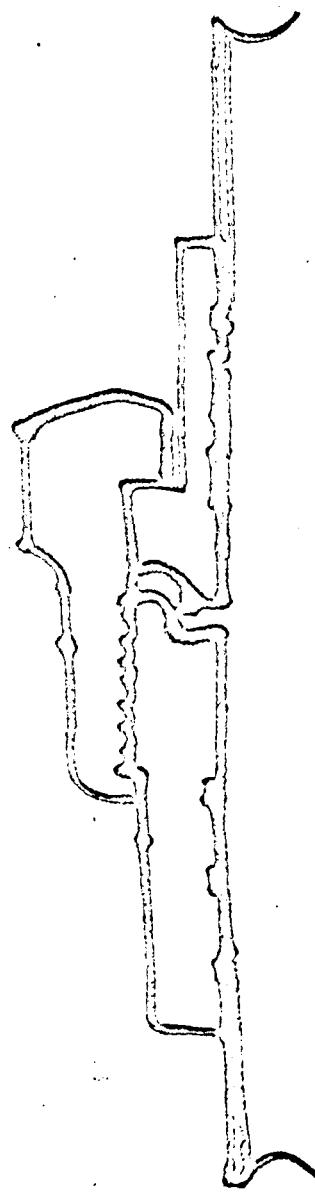
MECHANICAL JOINTS.

- GAMMAH
 - MILL-FLO
 - AIRPL-BOBBIN
 - RESISTORLEX
 - HARRISON ASTRO
 - MARMON CONOSEAL, ETC.
- THREADED

GA.MAH

METAL SEAL RING

EFFECTIVE WITH SOIL OMITTED



DYNAPIPE (RESISTOFLEX)

- PROTECTORS
- LOW TORQUE
- 40% LESS WEIGHT THAN STANDARDS



MIL-STD-10

SELF FLARING

- Complete Assembly
- Assembler
- Selected for X-20 Dyna-Soar

QUICK DISCONNECTIONS.

- NO TORQUE NEEDED
- SPRUNG CLOSED
- HEAVIER

PRELIMINARY FINDINGS

- LEAKS MUST BE ELIMINATED
- CAUSE OF LEAKS ARE UNKNOWN
- PRESENT JOINTS CAN BE IMPROVED
 - Protection of joints
 - Yolishan Washers
 - Reduction of Residual Stress
 - Superior units
- BETTER METHODS MAY BE APPLIED
 - More Advanced Mechanical Couplings
 - Possible In-Place Spraying of Aluminum

PRELIMINARY RECOMMENDATIONS

INVESTIGATE

- MEANS OF DETECTING RESIDUAL STRESS
- IN JOINTS
- BRAZING OF ALUMINUM TUBING IN-PLACE
- MORE ADVANCED MECHANICAL FITTINGS
- USE OF AEROQUIP BRAZING ON STEEL
- 0.2 LINES

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